



CHAPTER 11

**Functional Requirements of Korea
Joint Tactical Digital Information
Links***Chung Gyoo-Pil***Introduction**

At present, the ROK military incorporates the ATDL-1, Link-11/11B, Link-14, OS-OTG, and other U.S. systems for the ROK's master control reporting center and Korean naval tactical data system. There are also plans to acquire the Link-16 system in the future. Additionally, a number of indigenously developed technologies for building tactical digital information links are also in the works. TADIL must be revised and developed as we approach operations and applications in different ways developed by newly-introduced weapons systems. This is one of the reasons why, since the 1950s, the United States has continued to develop and enhance its TADIL program, which is still being upgraded as a result of new TADIL developments, continued efforts, and additional funds.

In a situation where the ROK is dependent on foreign TADILs and are not able to acquire an indigenously

developed TADIL system, a tremendous amount of the defense budget will have to be appropriated on the interface of weapon systems. Future expenditures will also continue to be siphoned into improving the efficiency of the existing TADIL system. Therefore, this chapter will outline the basic functional requirements and operational concepts for the development of Koreanized joint TADILs.

Tactical Digital Information Links (TADIL)

The U.S. Department of Defense Dictionary of Military and Associated Terms, Joint-Publication 1-02 dated April 12, 2001, defines the TADIL as follows:

... a standardized communication link appropriate for transmitting digital information, incorporating more than one communication structure and communications medium for tactical information exchange, which possesses more than two C2 systems or weapons system interface.

With surveillance, strike, and command and control systems, TADIL used as communications system, to provide interoperability acquirement and combat readiness between weapons systems through exchanging tactical information such as target position and identification information (like friend or foe, target classification, mission), armor information, target designation information, command, etc. The standard TADIL systems are the U.S. military's TADIL and NATO's standard link system. The characteristics of these data links will be described in this chapter.

Link-1

Link-1 was designed as a low-speed point-to-point communications data link in 1950. It has no consideration for security. It is a data link that is either a one- or two-way transmitter/receiver. The first Link-1 was initially introduced for NATO air defense ground environment and was used mainly for aerial surveillance by the U.S. military's control and reporting centers and combined air operations centers other than NATO.

Although the first Link-1 was developed using telephone lines, it was converted from and improved upon a multichannel radio communications system. Furthermore, through satellite communications and troop-scatter technology, Link-1 was composed in such a way that it could reach far beyond the line of sight. It is also possible to set options for data transmission speeds to 600bps or 2400bps. The general conditions for data transmission cycles depend on antenna scan cycles, 10-second periods, or the user's preferences. The Link-1 series specified above was widely used by NATO, Germany, Iceland, Italy, the Netherlands, Great Britain, and the United States. However, due to the limitations in data transmission speed and operational range, it is currently being replaced by other TADILs.

Link-4s

The Link-4s are non-secure data links generally used for communications between command authorities and combatants, and are divided into the Link-4A and Link-4C. The first Link-4s were designed for control of tactical aircrafts, but it has now been developed to the point where digital data exchange is possible between ground and aircrafts. Though Link-4s are non-secure links and do not

have any anti-jamming mechanisms, they are widely used in various Western armed forces because of the relative ease of operability and maintenance. The Link-4s use time division multiple access principles. In other words, by connecting two points by using dispersed intervals on each individual channel, it is possible for one controller to manage a number of aircraft on just one channel. The Link-4A (TADIL C) is widely used by the U.S. military and NATO for surface-to-air, air-to-surface, air-to-air tactical communication. Link-4C is supplementary to Link-4A for data communications between aircraft combatants. However, they are composed in such a way that direct communications between Link-4A and Link-4C is highly improbable if not impossible. Link-4A messages are divided into control messages and aircraft reply messages, and are defined by STANAG 5504. Control messages are defined as V-series messages, aircraft reply messages are defined as R-series messages. Of the Link-4s functions other than the automatic carrier landing system) supporting function, all other features are covered by Link-16, prompting the current changeover from Link-4s to the Link-16.

Link-11 and Link-11B

Link-11 is a communications system defined as standardized message convention and communications technology for digital information exchange for aircraft, ground, and naval vessels. Link-11 is based on netted architecture and polling protocol procedures. The Link-11 net generally uses roll call protocol. When participating units are polled by net-control stations, data is transmitted, and then Link-11 goes from transmission into reception mode so as to receive transmission data from other PUs. Link-11B Messages are transmitted through a point-to-point digital data link. Data can be transmitted at speeds of

600bps or multiples of 1200bps (e.g. 2400bps, 3600bps), and is usually transmitted at the standard data link speed of 1200bps. Data from Link-11/Link-11B are divided into 24-bit frames, and constitute two frames a message. Link-11/Link-11B are M-series messages as defined by the U.S. military standard MIL-STD-6011, MIL-STD-60011B and NATO standard STANAG 5511.

Link-14

Link-14 is a broadcast HF-teletype link aimed at transmitting surveillance information from naval vessels that have data processing capabilities to naval vessels that do not have the same sort of function. Teletype transmission systems are able to send long-range transmissions, providing target data to systems that are not able to receive Link-11 data. Depending on the type of communication that a system applies, Link-14 may utilize HF, VHF, and UHF bands. More than one Link-14 net, with or without separate transmitting units, may be set up if desired, e.g. to split air and surface/sub-surface data. However, some units will be limited by communications conformity in their capability to receive two nets. Few units will have the capability to transmit on two separate Link-14 channels at same time. Selection of a Link-14 transmitting unit will depend on force disposition stationing of non-TDS, Link-14 frequency, etc. Each member of NATO has a self-developed Link-14 transmitting pattern officially declared under AdatP-14, and the message protocol is defined in STANAG 5514.

Link-16

Link-16 is a term generally used by NATO, while TADIL-J is the U.S. military's terminology for the same system. Link-16 is the transceiving regulation and standardized

messaging method described in MIL-STD-6016. Joint tactical information distribution system is an electronics communications system that contains electronics software, hardware, and RF equipment. The purpose of Link-16 is to exchange command and control (voice and message), position and IFF information, and other tactical information safely, without the hazard of being jammed, into real-time tactical data. Link-16 is based on the time division multiple access principle. Each Link-16 node is allotted a transceiving time slot (one time slot is equivalent to 7.8125 msec). In former data links, a link that did not possess a particular node would have a problem of shutting down. However, for Link-16, even without a particular node, the system is designed to transmit within its allotted time slot and to receive within any slot, giving it a nodeless characteristic. Link-16 data rate depends on the existence of encryption, which ultimately decides what kind of packing structure will be used. Depending upon the packing structure, data rate is available at 28,800bps, 57,600 bps or 115,200bps. Fixed type, free text, and variable type are the three message types for Link-16. Fixed-type messages exchanged on Link-16 are defined in the J-series of MIL-STD-6016.

Link-22/NILE

The first Link-22 was developed under the name, NILE, or NATO Improved Link-Eleven, and can also be considered as a hybrid of the Link-16 and Link-11 components and structures. Since 1996, Canada, France, Germany, Italy, the Netherlands, Great Britain and the United States have participated in the design and development of Link-22, which was proposed by STANAG 5522 and ADatP 22 Draft. Depending on the circumstances, they plan to implement it from 2002 to 2009. Link-22 provides ECCM function, and is also a substitute for HF (3 – 30Mhz) or

UHF (225 – 40Mhz) fixed frequencies, providing the frequency hopping ability as a tactical data-communications system. Link-22 may select either TDMA or Dynamic TDMA, increasing flexibility and possessing a structure that decreases net management overhead. Link-22 is a member of the Link-16 family, and may transmit Link-16 J-series messages. Newer Link-22 messages are defined as F-series messages as defined in STANAG 5522 Draft.

CDL and TCDL

Common data link is a multi-purpose digital communications technology based on radio links that was first developed by the United States government for the purpose of image and signal intelligence-gathering systems application. This link uses microwaves, and provides full duplex or one-way communications between aerial/space platforms and ground terminals. CDL provides different applications/platforms with different services, which implies interoperable data link aggregations defined by five classes (Class I – Class V) of CDL. Standard Class I CDLs deal with the communications of ground/maritime terminals and aerial platforms executing operations under 80,000 feet in altitude and under Mach 2.3 of speed. Currently, ground and maritime terminals that support CDL Class 1s are respectively miniature interoperable surface terminal) and common high bandwidth data link surface terminal). Class II –Class V CDLS are for aircraft operating above the former: Class II - under 150,000ft./mach five, Class III - under 500,000ft., Class IV satellites - under 750 nautical miles, and Class V relay satellites above 750 nautical miles. The Pentagon has been working on the interoperability and standardization of Class I CDL systems.

Tactical common data link is used in a wide range of ISR that is low cost, and is designed as a light-weighted CDL-compatible data link. The first TCDL designs were for the application of UAVs, namely the Predator and Outrider, with additional applications in the works (Guardrail, Rivet Joint, Reef Point, ARL, Joint STARS). TCDL was designed to be operated within the Ku band, being able to substitute a variety of frequencies and operable on transmission speed. TCDL is able to uplink 200Kbps and downlink 10.71Mbps within a 200km radius. TCDL is presently interoperable with CDLs. They plan to have an interface with tactical control systems in the future. TCDLs include TCDL-gathering systems and TCDL ground/maritime terminals. They plan to provide real-time connection and interoperability with the current CDL systems.

SLP (Sensor Link Protocol)

The U.S. military's night vision/reconnaissance and target acquisition industrial management group (PMNV/RSTA) developed the sensor link protocol in order to connect host computers with reconnaissance/target acquisition sensors. SLP is expected to provide a secure sensor interface that may be used in information and electronics warfare.

CEC Data Link

Cooperative engagement capability is a revolutionary cooperative engagement concept for networking naval vessels or ground units, and all sensors' abilities to counter aerial attacks effectively, sharing real-time target data and giving the ability of remote war engagement as a unified regional aerial defense system. The CEC's main function is to provide sensor cooperation, data transmission and remote engagement of warfare. The CEC is generally

constituted of cooperative engagement processors and data distribution systems. The CEP analyzes target information that comes from DDS and operates to correct target position, specifying target number, track filtering, separating and merging. It consists of 30 microprocessors in those operations. This function is related to the other operations, supporting attack-control data, ship sensor, DDS, and combat system. DDS, controlling CEC data link, sends data in CEC systems and these supply abilities like receiving data from 30 NM and distributing data in 0.5 seconds simultaneously. Existing tactical data link control target information on the detect radio, but, DDS exchange target information of the tracking data simultaneously by Mbps data rate. To protect against jamming and automatic relay function, it must include a frequency-hopping function.

USMTF (U.S. Message Text Format)

USMTF is the text message format based on characters used to support the joint and combined operations of the tactical command and control system. The purpose of the USMTF is to reduce the necessary time and effort as it helps management. It supports an effective and economic communication system during joint operation exercise. USMTF is used for communication between the U.S. and combined forces. The U.S. Army uses USMTF message system in upper brigade class. Such standard of the USMTF message is defined in MIL-STD-6040.

VMF (Variable Message Format)

Variable message format is designed to exchange data in simultaneous time in a battle area. Early VMF is either fixed message format or VMF, and it is the Link-16 message. However, only the U.S. Army used VMF and

others did not use it. As the U.S. Army developed the VMF concept, VMF was separated from TADIL-J, and it is established as an independent standard. Today, it is used as standard for the AFATDS (Advanced Field Artillery Tactical Data System) in the U.S. Army and the U.S. Marine Corps. Especially, the U.S. Army set joint VMF message as standard to be used in all tactical systems.

The status of TADIL usage and necessity of TADIL in Korea

The status of TADIL usage and development trends

The United States uses ATDL-1, Link-1/4A/11/11B/14/16, VMF, USMTF, and develops Link-22, CDL, CEC data links. It also secures not only NATO and the U.S. Army tactical data link standards but also tactical data links of other nations such as Smart Data Link of Israel, Time Division Data Link of Japan, Link X of France. ATDL-1, MBDL, Link-11B, Crosstell of the 1st and 2nd MCRC of ROKAF and Link-11, Link-14, ISDL-A/B, TIBL of ROKN are in use, and development of Link-11 and Link-16 is in progress, which is for future integration with the Air Force's 2nd MCRC and F-X/AWACS. ROKN is engaged in enlarging and materializing the existing link through KNTDS project. They plan to implement the development of HELO Data Link between warships and helicopters. ROKA is embarked on developing the ATDL-1 class tactical data link for the system integration with other tactical systems.

Necessity for Korean model TADIL

We expect that future combat systems will be developed as a networked warfare potential system composed of

surveillance, control, and precise attack. The importance of tactical data links for weapon systems is poised to increase due to changes in national defense research and development requirements, especially in the area of the interoperability between weapon systems. As mentioned earlier, the need for these tactical data links within the Korean armed forces grows day by day. The following problems can be expected when already developed Tactical Data Links used by a third country are adopted for local use.

First, the ROK armed forces may face the difficulty in applying foreign TADILs to their own unique operational concept and tactical information. Second, the ROK armed forces may have to make cooperation requests well in advance if they decide to adopt the third country's standards and relevant property. Third, the ROK armed forces may experience considerable difficulties in adjusting foreign-made tactical data links whenever changes occur in their tactical needs. Fourth, in order to do maintenance on foreign-made tactical data links, as well as to provide for system interface between current weapons and newly acquired foreign tactical data links, the ROK armed forces will have to incur substantial costs on a continual basis. Fifth, in order to secure equipment that interlinks various tactical data links, the ROK armed forces will have to bear related acquisition costs and will have to face the challenges of complexity.

Therefore, in order to construct tactical data links that are optimal for future war conditions in Korea, it is necessary to minimize the technology dependency to foreign systems, to reduce maintenance costs for the equipment in question and to acquire a Koreanized Joint TADIL system, which improves the mission capability of the ROK armed forces.

Koreanized Joint Tactical Digital Information Links

Required capability

In order to formulate the required capability for the Koreanized tactical data links, one needs to consider the following factors -- Single tactical data links, function of the tactical data exchange, the function of the terminal equipment, communication capability which considers the Korean peninsular geographical features, capability that supports various communication mediums, interoperability supportable capability, and convenient maintenance and performance improvements in the future. Below are some specific requirements as per individual considerations.

Independent tactical data links

Since the 1950s, the United States developed tactical data links to support the newly-designed weapons systems and introduced the C2 concept, which became a tactical data links that possessed both various and overlapping capabilities. But, the designing of the message format and protocol by analyzing the comprehensive tactical exchange requirements between each unit, sensor system, C2 system, and weapons systems, required that the Koreanized tactical data links be simple and unified. Therefore, we need to make extra efforts to define a standardized message according to the unified tactical data links and to categorize available messages for transmission interface.

Function of tactical data exchange

Koreanized tactical digital information link has to provide for the exchange of appropriate tactical data for the ROK military's weapons systems in the mission of the ROK Army, Navy and Air force's tactical troops, and Army,

Navy and Air force's joint exercises. Appropriate communication system for joint exercises and tactical troops' environment, which have communication equipment. As for the environment in which strategic troops operate, they need support landline or radio communication with high frequency. Existing TADILs like VMF, USMTF, and Link-16 work well in such an environment. Therefore, Koreanized TADIL is necessary for ability to exchange tactical data that are dominant to Link-16, USMTF and VMF. Table 11.1 describes usage and communication method for Koreanized TADILs.

Table 11.1. Usage of Data Links

<i>Category</i>	<i>Usage</i>	<i>Communication Method</i>
Link-16 class	Joint operation for Korean Army, Navy, and Air Force	Satellite and Radio Terminals
USMTF class	Land strategic troops operation	TICN, LAN and WAN (TCP/IP, UDP)
VMF class	Land tactical troops operation	SPIDER Terminals

USMTF and VMF class tactical data can be transferred either through cable or the ROK military's SPIDER terminals or through the tactical information communication network terminal equipment, which is under development now. Development of the new terminal equipment is needed for transmitting tactical data like Link-16 class.

Function of terminal equipment

Transmission speed and security function of the terminal equipment, as a Koreanized TADIL, should supply the function of the upper level class, like JTIDS and MIDS, to transmit and receive tactical information. Existing Link-16 has disadvantages like complex network organization and low adaptability. Therefore, the next-generation terminal equipment should provide for additional and convenient network configuration. Terminal equipment should be modular planned by capabilities like processor, platform interface, communication system and antenna. The communication board should be equipped with the capability for UHF communication or satellite communication. The board should also support a hot-swapping capability function. Also, terminal equipment must be miniature, rugged, and light weight. Like JTIDS, constructing small and light weight terminal equipment is better than constructing variable terminal equipment for aircraft, ground vehicles, and naval vessels.

Function of communication support in operational environment

Since mountains occupy more than 70% of the total area in the Korean peninsula, terminal equipment must have a communication capability ensuring the terminal equipment's beyond line of sight communication for normal operation in mountainous topographical surroundings.

Function of variable communication systems

Koreanized TADIL will be needed not only for terminal equipment using Link -16 class messages but also for a system that can exchange information through variable

communication systems to maximize data distribution ability. Namely,

land line (cable, microwave, etc): LAN and
WAN (TCP/IP, UDP Internet, PSTN);

radio: HF, U/VHF, SPIDER, TICN, military
satellite, combat net radio).

Function of interoperability support

Koreanized TADIL will have to support a protocol transfer capability to ensure communication exchanges between the U.S. military Tactical Data Links used at present or to be used henceforth by the ROK military. The message control function of the Koreanized TADIL and the U.S. military TADIL and transforming message/ protocol functions have to be supported by tactical data processor).

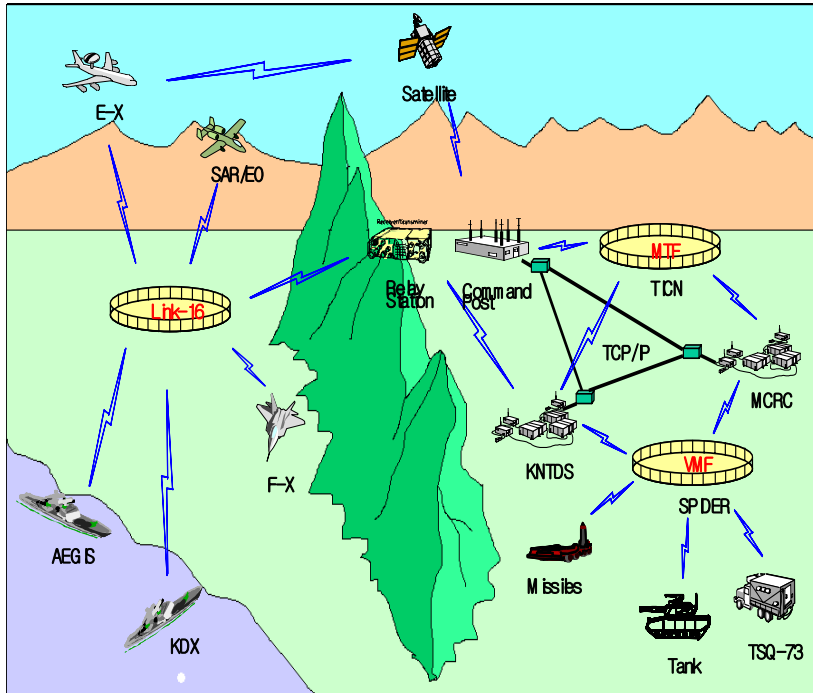
Ease of maintenance and performance development

One has to consider how easy it will be to do maintenance and to improve performance in Koreanized TADIL. All software used for terminal equipment and tactical information control link must be modularized by applying the COE and software defined radio in order to improve the ease of maintenance and reuse them. The ROK armed forces must be able to improve the system capability without hardware upgrades.

Concept of operation

The concept of operation of the Koreanized TADIL is described in Figure 11.1.

Figure 11.1. Operational Concept of Koreanized Tactical Digital Information Links



According to the distribution of tactical data message in Table 11.1, the Koreanized TADIL is transmitted through another communication system for the transfer of messages on Link-16, USMTF, and VMF class. The Link-16 class communication system exchanges tactical data simultaneously between Naval vessels, aircraft like AWACS, and Base C2 on the ground. Tactical data are exchanged through network and TICN between strategic troops above corps. Troops under division-level exchange tactical data through SPIDER or TICN. By tactical requirement, strategic troops on the ground install terminal

equipment of Link-16 class and exchange tactical data with other operational systems through network or military satellites.

Conclusion

The importance of tactical data links, which are able to collect tactical information from variable data resources and send it speedily to the users, is likely to increase dramatically on the future battlefield. Koreanized TADIL is a very important element in the development of the ROK armed forces and their ability to exchange data promptly and reliably among their services and units. Hence, the acquisition of the above-mentioned systems is indispensable and imperative for the ROK's military.

This chapter analyzed operational concepts and status of TADILs and introduced one of the ways to develop a useful guide of existing joint TADILs. In his findings, the author outlines a number of requirement functions and operation concepts for the Koreanized joint TADIL, which should have the ability to exchange tactical data like Link-16, USMTF, and VMF class. For transmission of tactical data, the ROK's military has to develop only terminal equipment for Link-16 class tactical data transmission. Transmission of other data should go through the ROK military communication systems, i.e., SPIDER and TICN.

Among existing TADILs, newly designed links like JTIDS and MIDS are based on the equipment developed using the technology of the 1980s. As we approach the technical limits of that technology, the ROK armed forces must design and develop a new generation of Koreanized joint TADILs, Link-16 class terminal equipment, adoptable to variable platforms of the future.

